# THE RELATION OF THE PERCENTAGE OF BANK RESERVES OF NATIONAL BANKS IN NEW YORK CITY TO THE CALL MONEY LOAN RATE ON THE NEW YORK STOCK EXCHANGE

In 1902, John P. Norton published a statistical study[1] of the relationship existing between the percentage of bank reserves in the national banks in New York City and the call money loan rates on the New York Stock Exchange. Mr. Norton's study covered the period between 1885 and 1900, and resulted in the establishment of an empirical relationship between the two phenomena, expressed by the correlation coefficient —.5231, for the period under observation. The object of the present study is two-fold:

1. To treat the succeeding period of nine years, 1901 to 1909 inclusive, after Mr. Norton's manner, in order to obtain a general correlation coefficient for this subsequent period.

2. To bring out more fully the nature and degree of the relationship existing between the two phenomena by supplementing Mr. Norton's somewhat summary treatment (as regard coefficients only, however), by a more detailed analysis; and thus, incidentally, to throw light on certain inadequacies inherent in correlation studies which rest satisfied with summary results, expressive of only a very general trend, and obtained only at a sacrifice of homogeneity in data and conditions.

The first part of our study, then, will follow closely the line pursued by Mr. Norton. The variations in the call money rates and in the reserve percentages are taken week by week from statistics compiled by the National Monetary Commission of 1910. They are given in Volume XXI, No. 1, pages 99 to 138, of the report of the Commission. The call rates employed are the arithmetic means of the rates in force for each of the 468 weeks of the

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[1] *Statistical Studies in the New York Money Market*, published for the Department of Social Sciences, Yale University, by the Macmillan Co., 1902.

period under study; except that the percentages are computed to the nearest one-half of 1 per cent for rates under 7 per cent, and to the nearest percentage for rates above that amount. The percentages of bank reserves are also averages for the week, computed to the nearest percentage. In two of the nine years under consideration, the calender year ended with but two days of the week elapsed; the rates and percentages for these two days are ignored in each case.

Norton's method of calculating the correlation coefficient is the double entry or double-frequency method. Like the formula indicated below, and used in this study, it is based on the Pearsonian *measure* of correlation, the Pearsonian coefficient being denoted by the formula:

$$r = \frac{\Sigma(xy)}{n\sigma_1\,\sigma_2}.$$

The formula which we shall employ

$$r = \frac{\Sigma xy - \dfrac{(\Sigma x)(\Sigma y)}{n}}{\sqrt{\left(\Sigma x^2 - \dfrac{(\Sigma x)^2}{n}\right)\left(\Sigma y^2 - \dfrac{(\Sigma y)^2}{n}\right)}}$$

yields the correlation coefficient, $r$, when $\Sigma xy$ (Sigma of $xy$) represents the sum of the products of $x$ and $y$ for each of the 468 weeks, $x$, the percentage of bank reserves, $y$, the average weekly call rates, the letter $\Sigma$ representing the sum, and $n$, the number of observations, in this case the number of weeks.

Taking the entire 468 weeks together, we have the following values for the symbols above:

$$\Sigma xy = 48,633.50$$
$$\Sigma x = 12,339.00$$
$$\Sigma y = 1,904.00$$
$$n = 468.00$$
$$\Sigma x^2 = 326,257.00$$
$$\Sigma y^2 = 17,288.51$$

Substituting these values in the equation above, and solving, we get

$$r = -.5244$$

Assuming a normal distribution and applying the formula

$$P.E. = .67449\frac{(l-r^2)}{\sqrt{n}}$$

for the probable error, we get $\pm.02260$ as the probable error of the correlation coefficient. The coefficient being more than twenty-three times the probable error, and being more than $\pm.50$, may be considered significant.

## INTERPRETATION OF THE COEFFICIENT

But, having established the correlation coefficient which is assumed to measure the degree of relationship existing between the percentage of bank reserves and the call money rate for the nine years under consideration, what concrete conclusions may actually, and legitimately, be drawn?

Our coefficient being negative, and high enough to be significant, we may say immediately that during the years 1901 to 1909 inclusive, there was an inverse relationship considering the period as a whole, between the size of bank reserves, regarded from a percentage basis, and the call money rate on the New York Stock Exchange. The degree of that inverse relationship is indicated by the fact that the coefficient is .5226 of a perfect, 1 to 1, correlation. The tendency, then, was for high call rates and low bank reserve ratios to go together, for low call rates and high bank reserve ratios to go together, and for call rates and bank reserve ratios to fluctuate inversely to each other.

Our correlation coefficient does not logically prove that there was any causal relation between bank reserve ratios and call money rates. But, a causal relation having been established on logical grounds, our correlation coefficient verifies, and gives some measure of, that causal relation; or, in the absence of prior logical proof of a causal relation, our coefficient indicates that there *may* be such a relation, logical proof of which might be adduced by adequate analysis; or, our correlation coefficient may indicate that bank reserve ratios and call money rates are merely inversely sympathetic functions of some third phenomenon or set of phenomena.

As a matter of fact, we do know that there is a causal relation between the percentage of bank reserves in the national banks

in New York City and the call money rates on the New York Stock Exchange. The call money rate of interest, like any other interest rate, is a price, and, in the hackneyed language of economists and quacks, any price is somehow a matter of supply and demand. The causal relation between the ratio of bank reserves (to deposits, of course), and the call money rate, then, is somehow a matter of the demand for and the supply of loanable funds available for call market purposes; for there is no influence working on any price that operates through channels other than the demand for and the supply of the given commodity.

Through which of these channels, the demand for or the supply of loanable funds, is this causal relation established, and from which end does causation proceed? We know in the first place, that the supply of loanable funds is in large measure a function of the ratio of bank reserves to deposits. Bankers wish to lend all the money they can, for it is from loans that their profits are derived. On the other hand, bankers must keep careful watch over their reserve ratios, for it is in these that their safety lies. Given a certain set of business conditions, there is an effective limit, irrespective of the legal limit, below which bankers cannot safely reduce their reserves. But as the reserve ratio rises above this limit, bankers have an increasing incentive to lend, and will do so, if necessary, at seemingly ridiculous rates (which not uncommonly go as low as three-quarters of one per cent). It would seem, then, that there should be a clear. case of correlation between the ratio of reserves and the call rate of interest. The higher the reserve ratios the lower the rates at which bankers will be willing to lend; the lower the reserve ratios, the higher the rates which must be offered to tempt bankers further to diminish their reserve ratios. It might seem, at first glance therefore, that there should be an almost perfect correlation between the ratio of bank reserves and the call money rate.

But this, of course, is a naïve and unwarranted deduction. The call money rate is determined not only through the supply side, but also through the demand. It is that rate, on any given day, at which the supply of and demand for loanable funds are equated. Influences manifesting themselves through the demand for funds may be quite as important, as regards the determination of the call

rate, as the supply influences (expressed largely through the reserve ratios). A great increase in the demand for loanable funds, due, say, to a speculative boom, will cause the call rate to rise without any prior decrease in the reserve ratio. And, moreover, after the effective reserve minimum has been reached, the call rate becomes almost exclusively a function of demand.

A perfect 1 to 1 correlation between the ratio of bank reserves and the call money rate, therefore, is not to be thought of. Demand exercises a distinct influence upon the price of call money loans. This chain of a priori reasoning finds ample verification in the correlation coefficient which summarizes the relations between reserve ratios and call rates in both Norton's study and in the present one. Norton found a relation expressed by $-.5231 \pm .0142$; the correlation coefficient for the years 1901 to 1909, as noted above, is $-.5244 \pm .0226$. The negligible difference in the coefficients for the two periods, .0013, is significant. Looked at as the measure of *all* the causes producing a given effect, a correlation coefficient of 1, positive or negative, could be obtained if all the causes and their combinations were known and could be statistically correlated to the single result. The difference between a given coefficient and a perfect one may therefore be regarded, loosely, as the measure of the relationship between the result and all other forces but the one for which the coefficient was obtained. Applying this view to our present problem, and assuming that the chief "other" forces are demand factors, we have a rough measure of the extent to which the demand forces influenced the call rate.

But, in fact, the situation is really more complex. Demand factors not only operate upon the call rate directly; but the call rate which results from partial or predominant demand influence affects in turn the reserve ratios. The great speculative boom above hypothetized, for example, will tend to force call rates upward without a prior decline in the reserve ratio; but the high rates in turn will tempt bankers to diminish their reserves to the minimum ratio compatible with safety or legal requirements. The high rates, in other words, will be partly *cause*, not altogether the effect, of a diminishing reserve ratio.

It may, perhaps, disarm critics here, if we point out that this reasoning does not partake of the common fallacy involved in a confusion of demand with demand schedules, or of supply with supply schedules. The increase in demand to which we refer as tending to raise call rates and thus diminish reserves is not that increase which normally results *from* a reduction in rates. It is rather that increase which manifests itself at every rate in the entire demand schedule. It is this kind of increase which raises prices; and the increased supply forthcoming at these higher prices does *not* tend to lower prices to the old level. In terms of our problem, the high call rates resulting from a real increase in the entire demand schedule *causes* banks to diminish their reserve ratios; and the increased supply of loanable funds thus made available does *not* tend to lower the call rate. These loanable funds, in this case, partake of the nature of an "increasing-cost" good. The call rate or price is in this case the result of *both* demand and supply influence.

We have answered then, perhaps, the question "Through which of these two channels, demand or supply, is the causal relation between reserve ratios and call rates established, and from which end does causation proceed?" The causal relation is established through both channels and causation proceeds from both sides. But this causation is not regular and varies as regards its strength, the channels through which it is established, and the end from which it proceeds. It varies with varying business conditions, with various phases of the business cycle. And the *degree* of relationship between reserve ratios and call rates, the impulse and channels of causation being ignored, also varies with the changing strength of the causal forces. It is at this point that the inadequacy of a correlation coefficient which attempts to summarize a general relationship extending over a period of changing conditions becomes apparent. Hence, it becomes desirable to present the data involved for each of the years singly. In this way we may obtain some idea of the forces and conditions which affect the degree and character of the relationship which is being studied.

The tables immediately below give the correlation coefficient, the average reserve ratio, and the average call rate for each of the nine years under consideration.

### CORRELATION BETWEEN RESERVE RATIOS
### AND CALL RATES
#### (By Years)

| Year | Correlation Coefficient | |
|------|-------------|----------|
| 1901 | −.300 | ±.0851(P.E.) |
| 1902 | −.2645 | ±.0869 |
| 1903 | −.4404 | ±.0754 |
| 1904 | −.7485 | ±.0411 |
| 1905 | −.4056 | ±.0781 |
| 1906 | −.6783 | ±.0505 |
| 1907 | −.5294 | ±.0673 |
| 1908 | −.6678 | ±.0518 |
| 1909 | −.4195 | ±.0770 |

### YEARLY AVERAGE RESERVE RATIO AND
### CALL RATE
#### (In Percent)

| Year | Reserve | Call Rate |
|------|---------|-----------|
| 1901 | 26.50 | 3.92 |
| 1902 | 26.05 | 5.16 |
| 1903 | 26.33 | 3.64 |
| 1904 | 27.46 | 1.74 |
| 1905 | 25.85 | 4.30 |
| 1906 | 25.69 | 6.38 |
| 1907 | 24.88 | 7.03 |
| 1908 | 28.35 | 1.85 |
| 1909 | 26.17 | 2.59 |

The most striking fact disclosed by a glance at the table of correlation coefficients is the wide fluctuation in the degree of relationship between reserve ratios and call rates. Evidently then, this relationship is no steady thing, despite the summarizing coefficient of −.5244; and this latter measure, unsupplemented by detailed analysis, might prove extremely misleading Not only the degree of correlation, but the factors in causation vary in strength and character under different business conditions, a fact which is clearly reflected in the lower table, if the business conditions associated with each of the years be brought to mind.

It will aid us in our interpretation of the table of coefficients if we study the fluctuations according to a classification of the chief factors which affect, favorably or adversely, the correlation between reserve ratios and call rates.

### A.  FACTORS WHICH MAKE FOR A HIGH DEGREE OF CORRELATION

1. Increasingly high reserve ratios tend to effect a decline in the call rate.   When the reserves are increasing and are already well above the effective lower limit, bankers have no incentive for restricting loans and every incentive for expanding them.   But the competition of many banks, each attempting to utilize its own excessive reserves, forces down the call rate.   Any rate at all may become a profitable one at which to lend.   Rates of less than 1 per cent are not at all uncommon in times of heavy reserve ratios. Generally, such times are associated with periods of depression or dullness, following the heavy liquidation caused by a crisis.   Such was the case in 1908, when the average call rate for the year was 1.85 per cent, the modal rate even less, and the reserve ratio, 28.35, the heaviest of any year in the nine-year period.   The year 1904 was another one of unusually heavy reserve ratios and unusually low call rates.   The average call rate in this year was 1.74 per cent the modal rate, 1 per cent.   *That these two years should show the highest degree of correlation between reserve ratios and call rates of any years in the period is significant.*   It is in years of overladen reserves that the factors which disrupt the correlation are least present; and the influence of the reserve ratios on the call rate the strongest. In such years the demand influences on the call rate are at a minimum (which itself explains, in large measure, the inflated character of the reserves), and the chief supply factor, the reserve ratios, exerts the greatest sway.

2. Diminishing reserve ratios, approaching, though not yet having reached, the minimum effective reserve requirements, force up the call rates; for when the reserve ratio is becoming thin, only high rates will tempt the banker to impinge farther on his margin of safety.   Periods in which this condition is prevalent, then, would be expected to show a high degree of inverse correlation between reserve ratios and call rates; though, as will be seen in a moment, the degree of correlation will not be so high as in a period of overladen reserves.   Such a condition would be likely to exist in a time of culminating prosperity which is yet short of that boom period which presages a crisis.   An excellent example of just such a time

is found in the year 1906 and part of 1907. The average call rate for 1906 was 6.38 per cent, and the average reserve ratio, 25.69 per cent. The high call rates, and the declining, through yet tolerable reserve ratios, combine to give a good degree of correlation. This close correlation for 1906 was aided also by another factor to be considered next, intimately related to the diminishing reserve ratio, but emanating from the demand side.

3. High call rates, resulting from a great increase in the *demand* for loanable funds rather than initially from low reserves, encourage the banker to expand his loans and thus to diminish more and more his reserve ratio. In the period from 1905 to 1907, there was a steady increase in the demand for loanable funds at rising rates of interest. In availing themselves of the high rates, the bankers steadily diminished their reserve ratios. Causation in this case, however, proceeded at first at least from the side of demand, from the side of the call rate. That this line of causation was quickly joined by a reciprocal line proceeding from the diminishing reserve ratios, and that this second line became increasingly prominent as the reserve ratio diminished, is not, of course, to be doubted; and it is clearly reflected in the reserve ratio and the call rate figure for 1906 and 1907. It is indeed exceedingly probable that following every period of high reserve ratios and business inactivity, the change in reserve ratios and call rates is initiated by demand influences, but that this line of causation becomes increasingly overshadowed by that emanating from the diminishing reserve ratios as these latter approach the effective lower limit.

B.    FACTORS WHICH ADVERSELY AFFECT THE CORRELATION BETWEEN
RESERVE RATIOS AND CALL RATES

1. Call rates rise at a more rapid pace than the fall in reserve ratios. This is only inadequately brought out in our tables, but some reflection of it may be seen in the figures for 1906 and 1907. The decline in the reserve ratio between 1905 and 1906 was .16 per cent; the rise in the call rate was 2.04 per cent. The decline in the reserve ratio between 1906 and 1907 was .43 per cent; the rise in the call rate, .65 per cent. The decline in the 1907 ratio was not really as great nor as abrupt for the greater part of the year as these figures would seem to indicate, for the ratio averaged only very

slightly lower than that of the preceding year for all but the last nine weeks of the year, when it dropped abruptly to 21 and 20 per cent. The fact that call rates rise more rapidly than reserve ratios fall, then, affects adversely the degree of correlation between the two phenomena. This adverse influence becomes more and more pronounced as the reserves reach the legal or effective minimum. When this is reached or passed, great jumps in the call rate will accomplish little or no further reduction in reserve ratios. This condition was approximated late in 1907 and was responsible for the lower correlation in that year. Significant reductions in the reserve ratios after this point has been reached are impossible save in the event of disastrous banking bankruptcies.

2. Unusual banking opportunities in money markets other than the call market and presence of large amounts of bankers' balances in the reserves are factors which adversely affect the correlation between reserve ratios and call rates. These factors, it is believed, explain the low correlation in the years 1901 and 1902. This period and the two years preceding comprised the great era of American corporate promotion and consolidation. The banking facilities of the country were taxed to finance the great reorganizations. Great sums of money poured into the New York banks from the interior, as bankers' balances, to help float the huge consolidations. The scope of banking operations in the call market was overshadowed by the operations of banking syndicates which helped to float the large issues of securities. The bankers were able to maintain fair-sized reserves on the surface, only by heavy borrowing, in the form of bankers' deposits, from interior banks. But reserves derived to a substantial extent from bankers' balances are qualitatively different from reserves derived from and maintained against ordinary deposits. Bankers' deposits are much more variable, often climbling quickly from insignificant amounts to huge balances and then evaporating as quickly one or more times during the year. Obviously, the reserve ratio against such deposits must be much higher than against ordinary deposits. The apparently substantial reserves of 1901 and 1902, then, were not so substantial as they appeared. On the other hand, bankers were unwilling to impair, by abnormally high call rates, the market-

ability of the vast amount of securities in which many of them were interested. Hence, the call rates were maintained as low as was compatible with minimum requirements. Before the middle of 1902, however, after large amounts of securities had been marketed, the call rate began to rise in response to qualitatively poor quality of the reserves, resulting in an average call rate for 1902 of 5.16 per cent.

3. In periods of moderate activity, the demand factors exercise a significant influence on the call rate, while the banks are still unwilling, in view of recent troubles, to freely expand their loans. This increases the influence of factors other than the reserve ratios upon the call rates and hence adversely affects the correlation betweeen reserve ratios and call rates. Examples of this condition are found in the years 1903, 1905, and 1909. The correlation coefficients of those years were $-.443$, $-.4056$, and $-.4195$, respectively, indicating the extent to which forces other than the reserve ratios were operating upon the call rate, and the extent to which forces other than the call rates, 3.64, 4.30, and 2.59 per cent respectively, were operating upon the reserve ratios.

Because the introduction of the Federal Reserve Banking System in 1912-13 has changed the character of our banking system, this study possesses little more than academic interest. It does, however, raise several interesting questions. It throws some light on the value of the correlation method, applied to periods and data of homogeneous character, in the economic field; it indicates an inviting field for the study of economic phenomena accordng to phases of the business cycle, by the application of the correlation method; and it suggests the inadequacy of considering banking reserves in their quantitative aspect alone, ignoring certain possible qualitative differences such as exist when the reserves are maintained against bankers' deposits.

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